NIST Develops Ion Mobility Spectrometric Methods for the Trace Detection of Illicit Narcotics

NIST is engaging in ongoing research aimed at determining the feasibility of using ion mobility spectrometry (IMS) for the rapid field identification of trace narcotics. Further advances in IMS technology have broadened its applications to the detection and identification of narcotics, human breath composition, and metabolites in bacteria. The use of IMS for trace detection of drugs has raised the intriguing possibility of using (simultaneously) the existing and widely deployed IMS explosives detection instruments for interdiction of narcotics and controlled substances. Such a capability may be of particular interest to US Customs and Border Patrol, the Drug Enforcement Agency (DEA), Federal Bureau of Investigations (FBI), the US Coast Guard and State and Local Law Enforcement.

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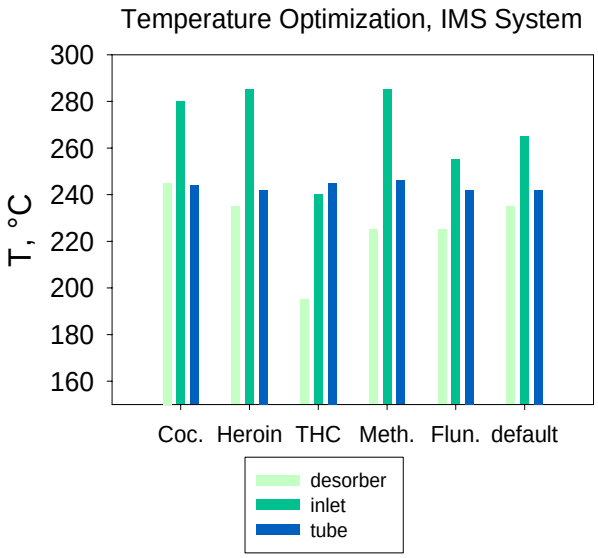
Ion mobility spectrometry (IMS) is a commonly used method for detecting and identifying volatile and semi-volatile organic compounds, principally in security and military venues.

Ion Mobility Spectrometry has the advantage of high sensitivity, high throughput, and low detection limits and as such is a promising approach for the trace detection of illegal narcotics.

IMS is based on determining the drift velocities attained by gaseous ions, derived from sample molecules, in a weak electric field and at ambient pressure. The formation of ions from neutral sample molecules is necessary to determine ion mobility. Current national priorities in homeland security have led to an unprecedented level of utilization of trace explosive detection systems for counter-terrorism and law enforcement. At present, more than 50,000 handheld IMS analyzers have been distributed for chemical-weapons monitoring within the armed forces of several nations and more than 10,000 bench-top analyzers are used as explosives detectors in airports worldwide.

A series of practical experiments measured fingerprint IMS spectra as well as the linear dynamic range and detection limits of a series of illicit narcotics including cocaine, heroin, THC and methamphetamine. Typical detection limits for these compounds are in the range of 0.1-100 ng, which corresponds to the detection of a single particle with a diameter of a few micrometers. A multivariate parameter approach was used to determine optimal instrumental conditions for the different narcotics. Parameters explored include desorber temperature, drift/tube temperature, and inlet temperature. In order to confirm the target compound was correctly identified, a database of false positive alarms and interferences was developed resulting from a wide variety of over-the-counter medications, household and personal care products. Excipients and/or diluents commonly found in street narcotics were also carefully screened to determine their effect, if any, on IMS response. In addition, practical sampling issues were studied including optimal swiping procedures for best sensitivity as well as the influence of possible environmental background signatures that may be relevant to trace narcotics detection (for example, the widespread contamination of US currency by cocaine).

Figure 1. IMS response from a commercial dual mode IMS system challenged with 100 nanograms of cocaine. The Spectrum shows cocaine detection alarm on the positive ion channel.



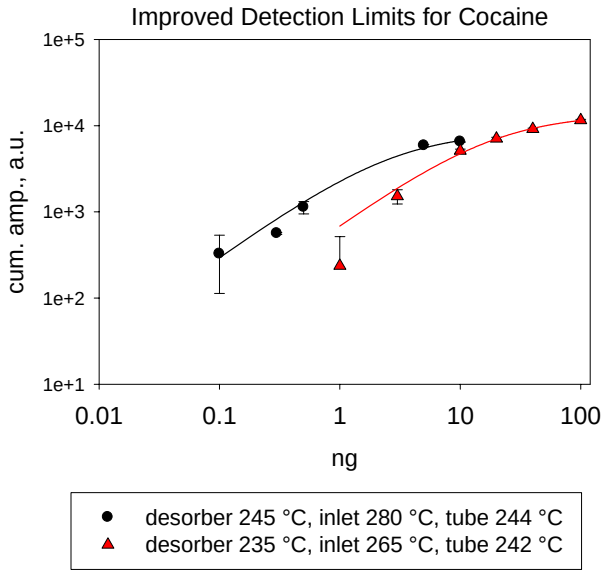


Figure 2(a). Optimal temperature settings for the desorber, inlet, and tube temperature for a commercial IMS system determined by noting optimal signal response for various illicit narcotics

Figure 2(b). Graph shows the improved limit of detection for cocaine using optimized temperature settings (seen in figure 2a) for a commercial IMS system

Future Plans: NIST researchers will continue a series of experiments using additional IMS instruments in order to establish a recommended alarm threshold level for drugs, further optimize parameters for the detection of a particular drug of interest as well as characterize a list of potential sources of false positives.